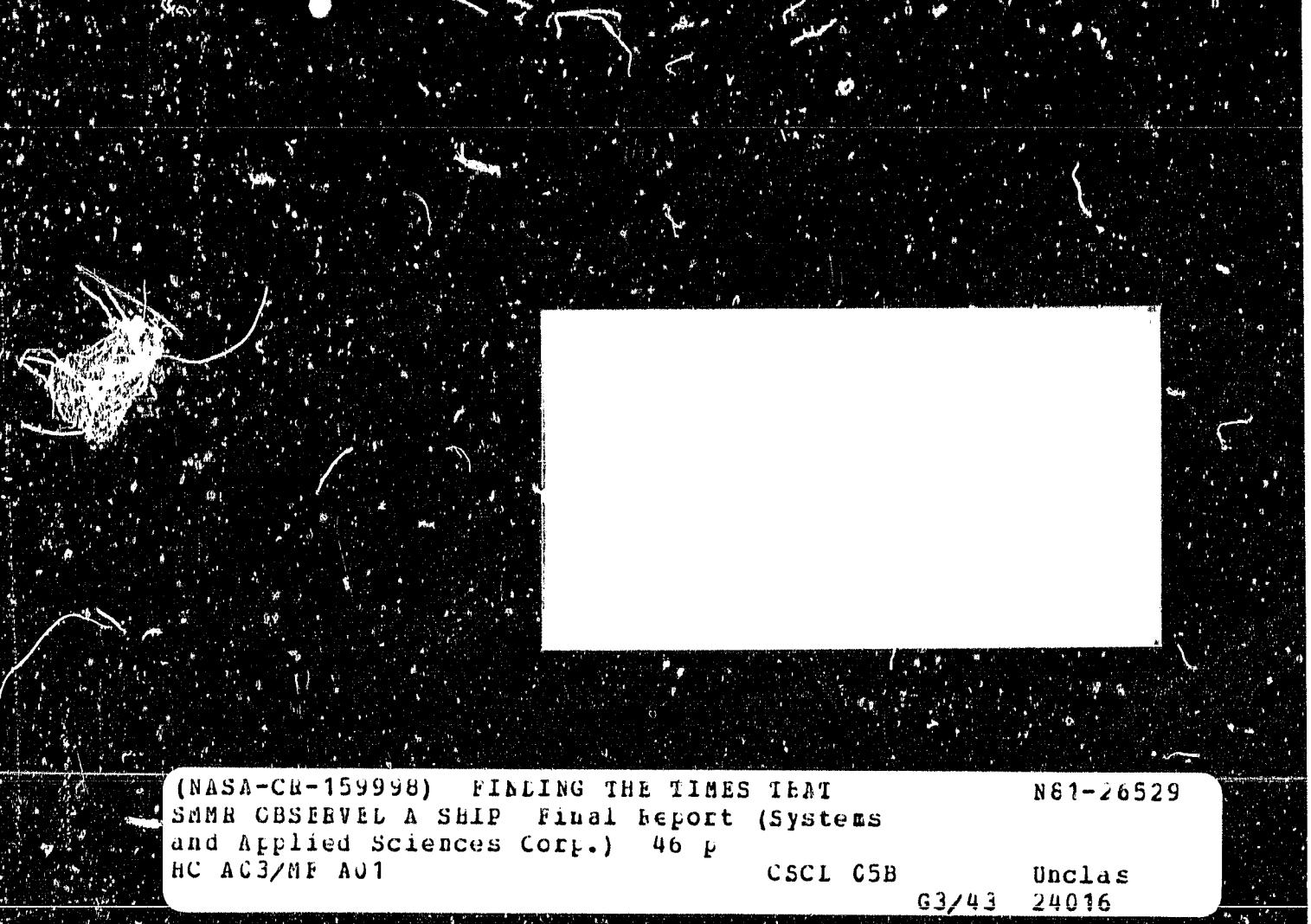

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FINDING THE TIMES THAT SMMR OBSERVED A SHIP

FINAL REPORT

R-SAR-79-01

FINDING THE TIMES THAT SMMR OBSERVED A SHIP

Final Report

Contract No. NAS5-25072

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II. Coordinate Transformation

In order to facilitate the coincidence calculations, the coordinates of the ship and the satellite are transformed to the ECO system, in which the equatorial plane is the plane of the satellite's orbit. The transformation from earth-centered fixed (ECF) to ECO coordinates is shown in Figure 1.

These are the transformation matrices for each step:

$$(1) \quad \underline{\lambda}' = \begin{pmatrix} \cos \alpha_t & -\sin \alpha_t & 0 \\ \sin \alpha_t & \cos \alpha_t & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

where

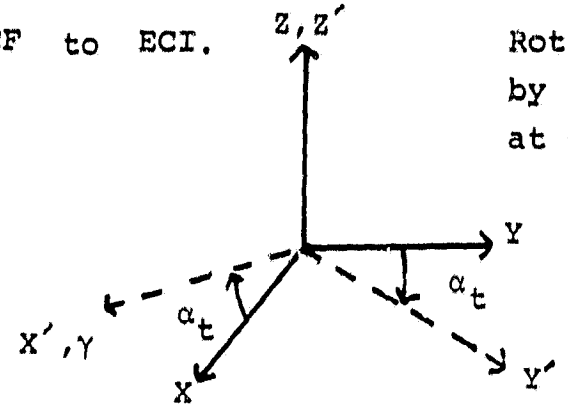
$$(2) \quad \alpha_t = \alpha_o + e_{rot} \cdot (t - t_o)$$

α_o is the Greenwich hour angle (GHA) of γ, the first point of Aries, at t_o

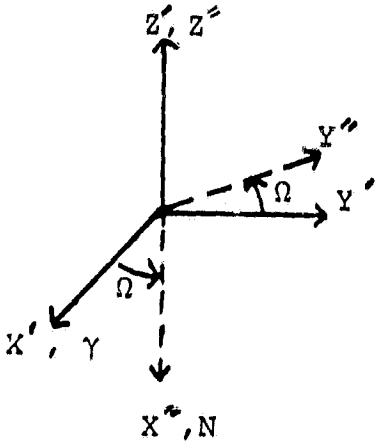
e_{rot} is the earth's rotation rate

Note: α_t, measured in radians, is the Greenwich sidereal time at Universal Time t.

Step (1) ECF to ECI. Rotate the equatorial plane by the Greenwich hour angle at time t (U.T.); α_t.



Step (2) Rotate ECI coordinates by Ω, the longitude of the ascending node.



Step (3) Tilt the equatorial plane by the inclination of the orbit.

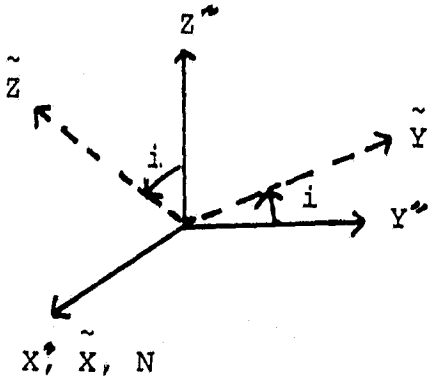


Figure 1

$$(3)\quad \underline{\lambda}'' = \begin{pmatrix} \cos\Omega & \sin\Omega & 0 \\ -\sin\Omega & \cos\Omega & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

$$(4)\quad \underline{\tilde{\lambda}} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos i & \sin i \\ 0 & -\sin i & \cos i \end{pmatrix}$$

The complete transformation is:

$$(5)\quad \underline{\lambda} = \underline{\tilde{\lambda}}\,\underline{\lambda}''\,\underline{\lambda}' = \begin{pmatrix} \cos(\Omega - \alpha_t) & \sin(\Omega - \alpha_t) & 0 \\ (-\cos i)\sin(\Omega - \alpha_t) & (\cos i)\cos(\Omega - \alpha_t) & \sin i \\ (\sin i)\sin(\Omega - \alpha_t) & (-\sin i)\cos(\Omega - \alpha_t) & \cos i \end{pmatrix}$$

The ECO coordinates of the ship are:

$$(6)\quad \begin{cases} X_{orb} = X\cos(\Omega - \alpha_t) + Y\sin(\Omega - \alpha_t) \\ Y_{orb} = \cos i\,[-X\sin(\Omega - \alpha_t) + Y\cos(\Omega - \alpha_t)] + Z\sin i \\ Z_{orb} = \sin i\,[X\sin(\Omega - \alpha_t) - Y\cos(\Omega - \alpha_t)] + Z\cos i \end{cases}$$

where X, Y, Z are the ship's ECF coordinates.

III. Calculation of Time Intervals

The ship can be observed when it is in a band about the equator in the ECO system. The width of the band (Z_{lim}) is determined by the scan pattern of the instrument. The first step in obtaining the times the ship enters and leaves the band is to set $Z_{orb} = \pm Z_{lim}$ in (6) and solve quadratic equations for cos α_t and sin α_t (see Appendix 1). We need both sin α_t and cos x_t so that we can put α_t in the proper quadrant. We then use (2) to calculate the U.T. times the ship is at the borders of the band in an interval of approximately 48 hours centered about the time of the ship's observation. Depending on the ship's latitude, there will be two, three, or four time intervals to be searched for coincidences.

IV. Existence and Times of Coincidence

The work of OTIME is nearly complete after the time intervals have been calculated. It calls LONGIT, which checks for the existence of a coincidence in each interval using the criterion:

$$(lon_{sat}(t_1) - lon_{ship}(t_1))\ (lon_{sat}(t_2) - lon_{ship}\ (t_2)) \leq 0 \qquad (7).$$

If the time interval is longer than the period of the satellite, LONGIT is restricted to searching the full period closest to the time of ship observation. Furthermore, if the interval is longer than half a period, it is split into three parts in order to avoid a breakdown of (7).

GETTIM uses a modified regula falsi technique to find the time of coincidence. The first step in the procedure uses the normal regula falsi technique. The number of iterations to be done is passed to the coincidence program from the main program. If convergence has not been reached after the iterations have been done, the second step is to determine in which half of the interval the root lies and repeat the first step using that half-interval. The maximum number of times the interval can be halved is also passed from the main program.

If convergence is reached, an empirical correction factor, which depends on the month being processed, is applied to the time of coincidence. The final time of coincidence is

$$t_f = t_c + (t_{corr1} \cdot t_c + t_{corr2})/60 \qquad (8)$$

where t_c = originally calculated time of coincidence (in hours)

t_{corr1}, t_{corr2} = correction factors.

The correction factors are obtained from plotting δt, the error in the calculated SMMR observation time, against Δt, the difference between the time of the ship observation and the SMMR observation time. Points which were observed by SMMR are read from the SMMR TLTs for three or four days spread over the month being processed. These points are fed to OTIME along with several ship observation times. These points fit a straight line whose slope, in minutes per hour, is t_{corr1} and whose δt-intercept is the negative of t_{corr2}.

V. How to Run the Program

The following shows how to use OTIME and describes the output. Unless otherwise noted, all variables listed below are REAL*8.

A. Input to OTIME

ALON, ALAT — The position of the ship. Units are degrees. The range of ALON is (0, 360), and it is measured positive to the west. The range of ALAT is (-90, +90).

TLIM — In GETTIM, the interval of coincidence is reduced until its length is less than the value of TLIM. A value of .01 minute is recommended.

NITER(I*4) — Also used in GETTIM, NITER is the number of iterations to be done before the time interval is halved. A value of 3 is recommended.

NHALF(I*4) — The maximum number of iterations is the product of NHALF and NITER. A value of 17 is recommended.

ITSOBS(I*4) — The hour (U.T.) of the day at which the ship made the observation. ITSOBS must be in the interval (0,24).

IDAYYR(I*4) — The day of the year on which the ship made the observation. Midnight of January 1, 1978 is day 0.0.

LYEAR(I*4) — The year in which the observation was made. LYEAR must have 4 digits, i.e., 1978 not 78.

TCORR1 — Time correction factors used in GETTIM. Units are minutes/hour. TCORR1 is read in by the namelist TIME from unit 9.

TCORR2 — Time correction factor used in GETTIM. Units are minutes. TCORR2 is read by the namelist TIME from unit 9.

When OTIME is called for the first time, it reads in TCORR1 and TCORR2 from unit 9, and from unit 11 it reads in a set of orbital elements and other information which enables it to calculate the ECI coordinates of the satellite at any time during the month which is being processed. The following cards must be included in the JCL for the GO step:

```
//GO.FT09F001   DD    *
     namelist input
```

and

```
//GO.FT11F001   DD    DSN=ZMMHT.ELTS.aaann,DISP=SHR
```

where aaa = first three letters of the month being processed

nn = last two digits of the year

B. Output from OTIME

TOBS: 4-element time vector containing times of coincidences measured relative to the time of observation (i.e., $t_{obs} = 0$). Units are hours (U.T.).

IFOBS: 4-element flag vector. If IFOBS(n) = 0, no coincidence occurred, but if IFOBS(n) = 1, a coincidence occurred, and TOBS(n) contains the time.

IERF: Error flag (see Sec. C).

C. Error Conditions

There is one error flag, IERF, which can take several values:

Value of IERF	Condition
a. Error conditions set in OTIME	
0	Normal
1	The elements passed to GKEP violated one of the following conditions: (i) The eccentricity was not in the range (0, 1). (ii) The semi-major axis was not in the range $(0, 1 \times 10^{35})$.
2	The year in which the observation was made does not match the year for which the orbital elements were read in.
3	Orbital elements were read in for a range of days which does not include the day the observation was made on.
4	The hour of the day is out of range.
5	The latitude of the ship is out of range.
6	The longitude of the ship is out of range.
7	The absolute value of a computed time is greater than 35 hours.

8	The time that the ship entered the band is greater than the time it left the band.
9	The ship remained in the band for more than one sidereal day.
15	One or both of LDAY0 and LDAYF, parameters which point to the first or last days for which orbital elements have been calculated, are out of range, or LDAY0 is greater than LDAYF.
16	Orbital elements do not exist for the day given by IDAYYR

b. Error conditions set in LONGIT.

10	Same as 7.
11	Same as 8.
12	Same as 9.

c. Error conditions set in GETTIM.

13	The differences in longitude between the ship and the satellite have the same sign at both endpoints of the time interval.
14	The time of coincidence (U.T.) has an absolute value greater than 30 hours.

NHALF*NITER	Convergence was not reached.

If an error is encountered, an error message is printed, control is returned to the main program, and no ruther processing is done.

D. Common Block

The common block CONST appears in all subroutines except GKEP. The following table lists the variables contained in CONST. They are all computed in OTIME:

X,Y,Z	ECF coordinates of ship.
ALON0	Longitude of satellite in ECO system at time of ship observation.
SREVH	Revolution rate of satellite about the earth in radians per hour (U.T.).
COSI, SINI	Cosine and sine of orbital inclination.
C1, C2	Constants used in calculation of X_{orb} and Y_{orb} (see (6)), and α_t (see App. 1).
T	Eight element vector containing endpoints of time intervals to be searched for coincidences.
TPI	2π.
EROTH	Rotation rate of earth, e_{rot}, in radians per hour (U.T.).
GHA0	GHA at time of ship observation.
TPIE	$2\pi/e_{rot}$
SINOM, COSOM	Sine and cosine of the longitude of the ascending node.
ERSINI	$-e_{rot} \cdot \sin(i)$ where $\sin(i)$ = SINI.
PERIOD	Period of satellite orbit as computed by Kepler's third law.
NTIMES	The number of time intervals to be searched for coincidences is NTIMES divided by 2.

E. Calling Sequence

CALL OTIME(ALON, ALAT, TOBS, TLIM, IFOBS, IERF, NHALF, NITER, ITSOBS, IDAYYR, LYEAR).

Appendix 1. Calculation of α_t

$$(\pm Z_{lim}/\sin i) = [x \sin\Omega - y \cos\Omega] \cos \alpha_t - [x \cos\Omega + y \sin\Omega] \sin \alpha_t + Z \cot i \quad \text{(A1-1)}$$

$$0 = A \cos \alpha_t - B \sin \alpha_t + C \quad \text{(A1-2)}$$

where

$$\left.\begin{aligned} A &= x \sin\Omega - y \cos\Omega \\ B &= x \cos\Omega + y \sin\Omega \\ C &= Z \cot i \mp Z_{lim}/\sin i \end{aligned}\right\} \quad \text{(A1-3)}$$

Let $\sin \alpha_t = \sqrt{1 - \cos^2 \alpha_t}$, then (A1-2) becomes

$$B^2 (1 - \cos^2 \alpha_t) = A^2 \cos^2 \alpha_t + 2AC \cos \alpha_t + C^2$$

$$0 = (A^2 + B^2)\cos^2\alpha_t + 2AC\cos\alpha_t + (C^2 - B^2)$$

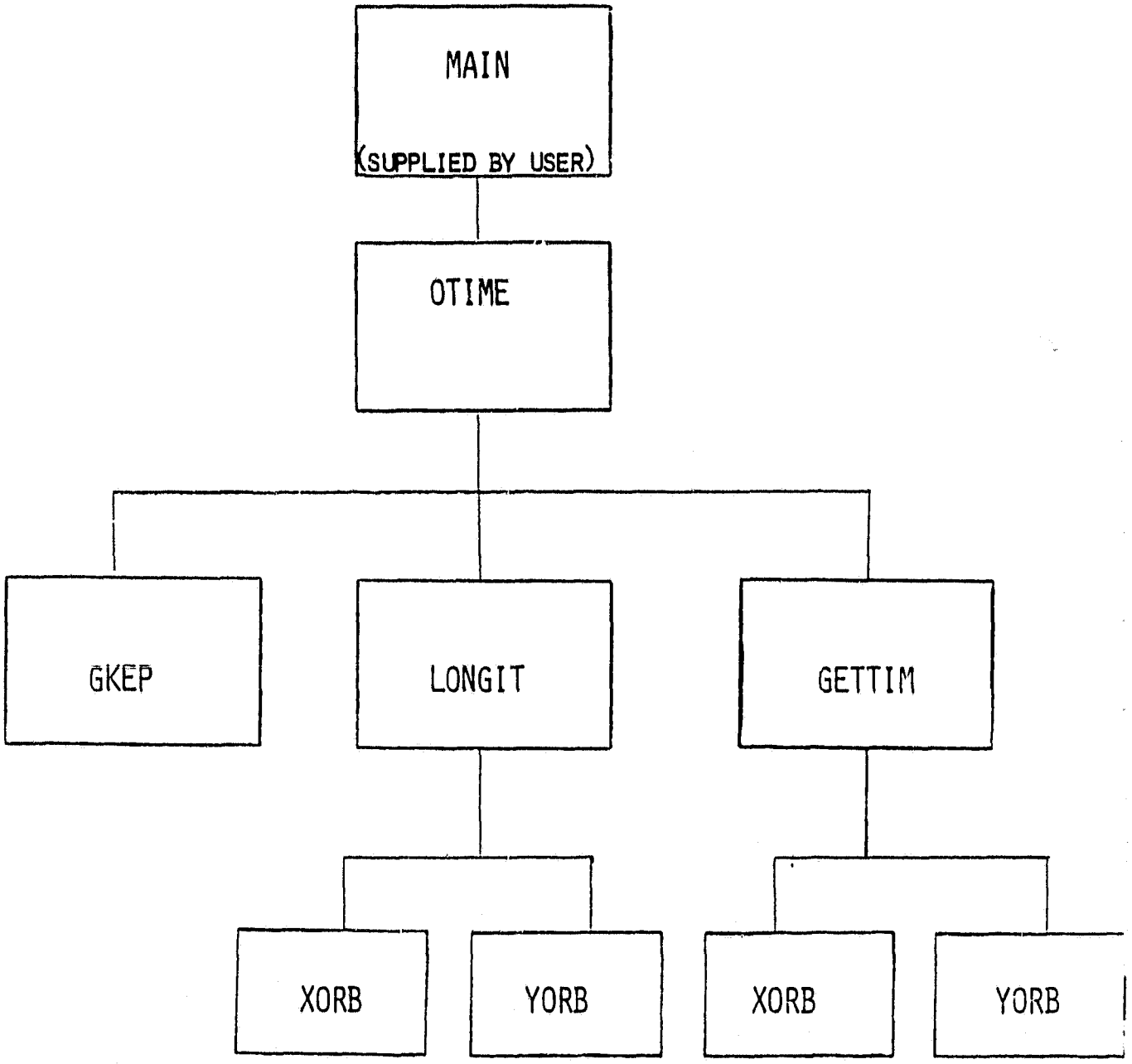
$$\cos\alpha_t = \frac{-2AC \pm \sqrt{4A^2C^2 - 4(A^2 + B^2)(C^2 - B^2)}}{2(A^2 + B^2)}$$

Now, $A^2 + B^2 = x^2 + y^2 = D$, so

$$\cos\alpha_t = \frac{-AC \pm \sqrt{A^2C^2 - D(C^2 - B^2)}}{D} \qquad \text{(A1-4)}$$

Now we go back to (A1-2) and set $\cos\alpha_t = 1 - \sin^2\alpha_t$. This gives us

$$\sin\alpha_t = \frac{BC \pm \sqrt{B^2C^2 - D(C^2 - A^2)}}{D} \qquad \text{(A1-5)}$$



Appendix 2. Block Diagram

APPENDIX 3

```
          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=56,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
  ISN 0002            SUBROUTINE OTIME(ALON,ALAT,TOBS,TLIM,IFOBS,IERR,NHALF,NITER      00000010
                     $     ,ITSOBS,IDAYYR,LYEAR)                                      00000020
                C                                                                     00000030
                C   SUBROUTINE OTIME CALCULATES THE TIMES THE SHIP ENTERS AND LEAVES 00000040
                C   THE EQUATORIAL BAND (IN THE ECO SYSTEM)                          00000050
                C                                                                     00000060
                C   INPUT VARIABLES:  ALON, ALAT (IN DEGREES) ---  POSITION OF SHIP  00000070
                C                                                                     00000080
                C                      ITSOBS--  HOUR (U.T.) OF DAY SHIP              00000090
                C                                OBSERVATION WAS MADE ON              00000100
                C                                                                     00000110
                C                      IDAYYR--  DAY OF THE YEAR                      00000120
                C                                                                     00000130
                C                      LYEAR--  YEAR                                 00000140
                C                                                                     00000150
                C                      TLIM, NHALF, NITER--  SEE SUBROUTINE GETTIM    00000160
                C                                                                     00000163
                C                      TCORR1, TCORR2--  USED IN GETTIM. READ IN BY   00000164
                C                                        OTIME USING NAMELIST TIME    00000165
                C                                                                     00000166
                C                      ELTS1, ELTS2--  ARRAYS, READ IN BY OTIME, WHICH 00000167
                C                                      CONTAIN ORBITAL ELEMENTS AND   00000168
                C                                      OTHER INFORMATION (SEE BELOW)  00000169
                C                                                                     00000170
                C   OUTPUT VARIABLES:  T--  TIME VECTOR WHICH CONTAINS THE TIMES THE 00000180
                C                          SHIP ENTERS AND LEAVES THE BAND FOR THE    00000190
                C                          EQUATOR CROSSINGS (MAX. OF 4) CICSFST TO TIME 00000200
                C                          OF OBSERVATION.  ALL TIMES ARE IN HOURS.   00000210
                C                                                                     00000220
                C                       TOBS--  SEE SUBROUTINE GETTIM                 00000230
                C                                                                     00000240
                C                       IFOBS--  SEE SUBROUTINE LONGIT                00000250
                C                                                                     00000260
                C                       IERR--  ERROR FLAG                            00000270
                C                                                                     00000280
                C   CONSTANTS:  EROTH--  ROTATION RATE OF EARTH IN RADIANS PER HOUR  00000290
                C                                                                     00000300
                C                GM--  GRAVITATIONAL CONSTANT TIMES MASS OF EARTH    00000310
                C                                                                     00000320
                C                ZLIM--  HALF-WIDTH OF BAND IN KILOMETERS           00000330
                C                                                                     00000340
                C                SIDDAY--  SIDEREAL DAY IN U.T. HOURS                00000350
                C                                                                     00000360
                C                RE--  RADIUS OF EARTH WHICH IS ASSUMED TO BE SPHERICAL 00000370
                C                                                                     00000380
                C   SUBROUTINES CALLED:  GRDE, LONGIT, GETTIM                        00000390
                C                                                                     00000400
                C   CALLED BY:  MAIN                                                 00000410
                C                                                                     00000420
                C   PROGRAMMED BY MICHAEL TOPOREK, SASC, 7/79                        00000425
                C                                                                     00000426
  ISN 0003            IMPLICIT REAL*8 (A-H,O-Z)                                     00000430
```

```
ISN 0004          DIMENSION GHA1(4),T(8),ZCHBT(4),TOBS(4),IFOBS(4),DZOBT(4)          00000440
                 $     ,XSCI(6)                                                     00000450
ISN 0005          DIMENSION ITLTS1(35,2),ELTS2(35,9)                               00000460
ISN 0006          COMMON /CONST/ X,Y,Z,AICNO,SECVH,COSI,SINI,C1,C2,T,IFI,          00000470
                 $     EBOTE,GHAO,TPIE,SINCH,COSOM,                                00000480
                 $     ERSINI,PERIOD,NTIMES                                        00000490
ISN 0007          DATA IREAD/0/,GM/.3986032D6/                                     00000500
ISN 0008          DATA ZLIM/200.D0/,SIDDAY/23.9300696DD/                           00000510
ISN 0009          DATA PI/3.141592653589793D0/,RT/6.3677425D3/                     00000520
ISN 0010          NAMELIST /TIME/ TCORR1,TCORR2                                    00000525
ISN 0011        9 FORMAT(/20X,'** ERROR(CTIME) ** NO ORBITAL ELEMENTS FOR DAY',I5,  00000610
                 $     ' ** ERROR(OTIME) **'/)                                     00000620
ISN 0012       10 FORMAT(/20X,'** ERROR(OTIME) ** YEAR OF OBSERVATION=',I5,' DOES ' 00000630
                 $     ,'NOT MATCH YEAR OF ORBITAL ELEMENTS=',I5,' ** ERROR(OTIME) **00000640
                 $     '/)                                                         00000650
ISN 0013       11 FORMAT(/20X,'** ERROR(OTIME) ** DAY OF OBSERVATION=',I5,' IS NOT' 00000660
                 $     ,' IN RANGE=(',I5,',',I5,') ** ERROR(OTIME) **'/)          00000670
ISN 0014       12 FORMAT(/20X,'** ERROR(OTIME) ** TIME OF OBSERVATION=',I5,' IS NOT'00000680
                 $     ,' IN RANGE=(0,24) ** ERROR(OTIME) **'/)                    00000690
ISN 0015       13 FORMAT(/20X,'** ERROR(CTIME) ** LATITUDE OF SHIP=',F6.1,'DEG. IS' 00000700
                 $     ,' NOT IN RANGE=(-90,+90) ** ERROR(OTIME) **'/)             00000710
ISN 0016       14 FORMAT(/20X,'** ERROR(OTIME) ** LONGITUDE OF SHIP=',F6.1,' IS NOT'00000720
                 $     ,' IN RANGE=(0,360) ** ERROR(OTIME) **'/)                   00000730
ISN 0017       15 FORMAT(/20X,'** ERROR(OTIME) ** THE ELEMENTS PASSED TO GKPP WERE' 00000740
                 $     ,' WRONG ** ERROR(CTIME) **'/)                              00000750
ISN 0018       16 FORMAT(/20X,'** ERROR(CTIME) ** ABSOLUTE VALUE OF COMPUTED TIME ',00000760
                 $     'IS GREATER THAN 35 HOURS ** ERROR(OTIME) **'/)             00000770
ISN 0019       17 FORMAT(/20X,'** ERROR(CTIME) ** TIME OF ENTRANCE INTO BAND IS ', 00000780
                 $     'GREATER THAN TIME OF EXIT ** ERROR(OTIME) **'/)            00000790
ISN 0020       18 FORMAT(/20X,'** ERROR(CTIME) ** THE SHIP IS IN THE BAND FOR MORE' 00000800
                 $     ,' THAN ONE SIDEREAL DAY ** ERROR(OTIME) **'/)              00000810
ISN 0021       19 FORMAT(/20X,'** ERROR(OTIME) ** LDAYO=',I3,' OR LDAYF=',I3,' OUT' 00000820
                 $     ,' OF RANGE=(1,35) OR LDAYO.GT.LDAYF ** ERROR(CTIME) **'/)  00000830
                C                                                                 00000840
                C     WHEN THE SUBROUTINE IS CALLED FOR THE FIRST TIME, READ IN   00000850
                C     TIME CORRECTION CONSTANTS, ORBITAL ELEMENTS, AND OTHER DATA, 00000860
                C     AND CALCULATE SOME CONSTANTS                                00000865
                C                                                                 00000870
ISN 0022              IF(IREAD.NE.0) GO TO 100                                    00000880
ISN 0024              IREAD=1                                                     00000890
ISN 0025              READ(9,TIME)                                                00000895
ISN 0026              WRITE(6,TIME)                                               00000896
ISN 0027              READ (11) ITLTS1,ELTS2,LDAYO,LDAYF,IYEAR                    00000900
                C                                                                 00000910
                C     ITLTS1(N,1)=DAY OF THE YEAR                                 00000920
                C     ITLTS1(N,2)=1 IF ORBITAL ELEMENTS EXIST FOR THE DAY,        00000930
                C                 DOES NOT EQUAL 1 IF ELEMENTS DO NOT EXIST       00000940
                C                                                                 00000950
                C     ELTS2(N,1)=SEMI-MAJOR AXIS (KILOMETERS)                     00000960
                C     ELTS2(N,2)=ECCENTRICITY                                     00000970
                C     ELTS2(N,3)=INCLINATION (RADIANS)                            00000980
                C     ELTS2(N,4)=LONGITUDE (RADIANS) OF THE ASCENDING NODE AT 0 HRS U.T.  00000990
                C     ELTS2(N,5)=RATE OF CHANGE OF LONGITUDE OF THE ASCENDING NODE 00001000
                C                 (RADIANS/DAY)                                   00001010
```

```
C   ELTS2(N,6)=MEAN MOTION (RADIANS/DAY)                                    00001020
C   ELTS2(N,7)=MEAN ANOMALY (RADIANS) AT 0 HRS U.T.                         00001030
C   ELTS2(N,8)=ASCENDING NODE CROSSING AT (IELTS1(N,1) -(MEAN ANOMALY AT    00001040
C              0 HRS)/(MEAN MOTION))                                        00001050
C   ELTS2(N,9)=GREENWICH HOUR ANGLE (RADIANS) AT 0 HRS U.T.                 00001060
C                                                                           00001070
C   LDAY0=VALUE OF N POINTING TO FIRST DAY FOR WHICH ELEMENTS EXIST         00001080
C   LDAYF=VALUE OF N POINTING TO LAST DAY FOR WHICH ELEMENTS EXIST          00001090
C   LYEAR=YEAR FOR WHICH ELEMENTS WERE COMPUTED                             00001100
C                                                                           00001110
ISN 0028          DTR=PI/180.D0                                             00001120
ISN 0029          TPI=2.D0*PI                                               00001140
ISN 0030          SROTH=TPI/SIDAY                                           00001145
ISN 0031          TPID=TPI/MROTH                                            00001150
ISN 0032        100 IERF=0                                                  00001160
C                                                                           00001170
C   CHECK VALIDITY OF INPUT                                                 00001180
C                                                                           00001190
ISN 0033          IF((LDAY0.LT.1).OR.(LDAYF.GT.35).OR.(LDAY0.GT.35).OR.(LDAYF.LT.1).00001200
                 $     OR.(LDAY0.GT.LDAYF)) IERF=15                         00001210
ISN 0035          IF(IERF.NE.0) WRITE(6,19) LDAY0,LDAYF                     00001220
ISN 0037          IF(IERF.NE.0) RETURN                                      00001230
ISN 0039          IF(LYEAR.NE.IYEAR) IERF=2                                 00001240
ISN 0041          IF(IERF.NE.0) WRITE(6,10) IYEAR,IYEAR                     00001250
ISN 0043          IF(IERF.NE.0) RETURN                                      00001260
ISN 0045          IF((IDAYYR.LT.IELTS1(LDAY0,1)).OR.(IDAYYR.GT.IELTS1(LDAYF,1)))  00001270
                 $     IERF=3                                               00001280
ISN 0047          IF(IERF.NE.0) WRITE(6,11) IDAYYR,IELTS1(LDAY0,1),IELTS1(LDAYF,1)  00001290
ISN 0049          IF(IERF.NE.0) RETURN                                      00001300
ISN 0051          IF((ITSOBS.LT.0.D0).OR.(ITSOBS.GT.24.D0)) IERF=4          00001310
ISN 0053          IF(IERF.NE.0) WRITE(6,12) ITSOBS                          00001320
ISN 0055          IF(IERF.NE.0) RETURN                                      00001330
ISN 0057          IF(DABS(ALAT).GT.90.D0) IERF=5                            00001340
ISN 0059          IF(IERF.NE.0) WRITE(6,13) ALAT                            00001350
ISN 0061          IF(IERF.NE.0) RETURN                                      00001360
ISN 0063          IF((ALON.LT.0.D0).OR.(ALON.GT.360.D0)) IERF=6             00001370
ISN 0065          IF(IERF.NE.0) WRITE(6,18) ALON                            00001380
ISN 0067          IF(IERF.NE.0) RETURN                                      00001390
C                                                                           00001400
ISN 0069          NTIMES=4                                                  00001410
C                                                                           00001420
C   MAKE SURE ORBITAL ELEMENTS EXIST FOR THE DAY OF THE SHIP OBSER-         00001425
C   VATION, PUT KEPLERIAN ELEMENTS INTO XECI, CALCULATE SOME CONSTANTS,     00001430
C   AND CALL GKEP TO GET INERTIAL COORDINATES OF SATELLITE                  00001435
C                                                                           00001440
ISN 0070          IDAY=IDAYYR-IELTS1(LDAY0,1)+LDAY0                         00001450
ISN 0071          IF(IELTS1(IDAY,2).NE.1) IERF=15                           00001455
ISN 0073          IF(IERF.NE.0) WRITE(6,9) IDAYYR                           00001460
ISN 0075          IF(IERF.NE.0) RETURN                                      00001470
ISN 0077          XECI(1)=ELTS2(IDAY,1)                                     00001485
ISN 0078          XECI(2)=0.D0                                              00001490
ISN 0079          XECI(3)=ELTS2(IDAY,3)                                     00001500
ISN 0080          DTSOBS=DFLOAT(ITSOBS)/24.D0                               00001510
ISN 0081          XECI(6)=ELTS2(IDAY,6)*ELTS2(IDAY,5)*DTSOBS                00001520
```

```
ISN 0082            XSCI(5)=0.D0                                                    00001530
ISN 0083            XSCI(6)=DMOD((SLTS2(IDAY,6)*(DTSOES)+SLTS2(IDAY,7)),TPI)        00001540
ISN 0084            SINI=DSIN(SLTS2(IDAY,3))                                        00001550
ISN 0085            COSI=DCOS(SLTS2(IDAY,3))                                        00001560
ISN 0086            SINOM=DSIN(XSCI(4))                                             00001570
ISN 0087            COSOM=DCOS(XSCI(4))                                             00001580
ISN 0088            GHA0=DMOD((SLTS2(IDAY,9)+6.300388736D0*DTSOES),TPI)             00001590
ISN 0089            THETA0=XSCI(4)-GHA0                                             00001600
ISN 0090            SRSINI=-SROTH*SINI                                              00001610
ISN 0091            CALL GKEP(GM,XPCI,IERF)                                         00001620
ISN 0092            IF(IERF.NE.0) WRITE(6,15)                                       00001630
ISN 0094            IF(IERF.NE.0) RETURN                                            00001640
                C                                                                   00001650
                C   FIND INITIAL SATELLITE LONGITUDE IN ECO SYSTEM                  00001660
                C                                                                   00001670
ISN 0096            XSORB=XSCI(1)*COSOM+YSCI(2)*SINOM                               00001680
ISN 0097            YSORB=COSI*(-XSCI(1)*SINOM+YSCI(2)*COSOM)+ZSCI(3)*SINI          00001690
ISN 0098            ALONO=DATAN2(YSORB,XSORB)+8.3D0*DTR                             00001700
ISN 0099            IF(ALONO.LT.0.D0) ALONO=TPI+ALONO                               00001720
                C                                                                   00001730
                C   COMPUTE SATELLITE REVOLUTION RATE AND PERIOD                    00001740
                C                                                                   00001750
ISN 0101            R=DSQRT(XSCI(1)*XSCI(1)+YSCI(2)*YSCI(2)+ZSCI(3)*ZSCI(3))        00001760
ISN 0102            V=DSQRT(XSCI(4)*XSCI(4)+YSCI(5)*YSCI(5)+ZSCI(6)*ZSCI(6))        00001770
ISN 0103            SMA=1.D0/(2.D0/R-V*V/GM)                                        00001780
ISN 0104            SRATE=(DSQRT(GM)/DSQRT(SMA*SMA*SMA))*3600.D0                    00001790
ISN 0105            PERIOD=TPI/SRATE                                                00001800
                C                                                                   00001810
                C   CONVERT LONGITUDE AND LATITUDE TO RADIANS, AND RESET FLAGS      00001820
                C   TAKE NEGATIVE OF ALON BECAUSE INPUT LONGITUDE IS MEASURED      00001825
                C   POSITIVE TO THE WEST, AND COORDINATE SYSTEMS USED IN THIS       00001826
                C   PROGRAM MEASURE LONGITUDE POSITIVE TO THE EAST                  00001827
                C                                                                   00001830
ISN 0106            ALON=-ALON*DTR                                                  00001840
ISN 0107            ALAT=ALAT*DTR                                                   00001850
ISN 0108            DO 110 IJ=1,4                                                   00001860
ISN 0109          110 IOBS(IJ)=0                                                    00001870
ISN 0110            IFL=0                                                           00001880
ISN 0111            IFL2=0                                                          00001890
                C                                                                   00001910
                C   CALCULATE X, Y, Z--- COORDINATES OF SHIP IN ECF SYSTEM        00001920
                C                                                                   00001930
ISN 0112            X=RE*DCOS(ALAT)*DCOS(ALON)                                      00001940
ISN 0113            Y=RE*DCOS(ALAT)*DSIN(ALON)                                      00001950
ISN 0114            Z=RP*DSIN(ALAT)                                                 00001960
                C                                                                   00001970
                C*******************************************************************00002000
                C                                                                  *00002010
                C                                                                  *00002011
                C                                                                  *00002012
                C                                                                  *00002013
                C   CALCULATE TIMES OF BAND CROSSINGS IN ECO SYSTEM                00002020
                C                                                                   00002030
ISN 0115            C1=X*SINOM-Y*COSOM                                              00002040
```

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ISN 0116          C2=X*CDSCM+Y*SINCM                                          00002050
ISN 0117          C3=Z/DTAN(PITS2(IDAY,3))                                    00002060
ISN 0118          C4=X*X+Y*Y                                                  00002070
ISN 0119          C5=C3-ZLIM/SINI                                             00002080
ISN 0120          C6=C3+ZLIE/SINI                                             00002090
ISN 0121          C1S=C1*C1                                                   00002100
ISN 0122          C2S=C2*C2                                                   00002110
ISN 0123          C5S=C5*C5                                                   00002120
ISN 0124          C6S=C6*C6                                                   00002130
ISN 0125          D1=(C5S*C1S)-(C5S-C2S)*C4                                   00002140
ISN 0126          D2=(C6S*C1S)-(C6S-C2S)*C4                                   00002150
ISN 0127          D3=(C5S*C2S)-(C5S-C1S)*C4                                   00002160
ISN 0128          D4=(C6S*C2S)-(C6S-C1S)*C4                                   00002170
                  C                                                           00002180
ISN 0129          IF(D3.GE.0.D0) COST1=((-C5*C1)+DSQRT(D1))/C4                00002190
ISN 0131          IF(D3.GE.0.D0) COST3=((-C5*C1)-DSQRT(D1))/C4                00002200
ISN 0133          IF(D3.GE.0.D0) SINT1=((C5*C2)+DSQRT(D3))/C4                 00002210
ISN 0135          IF(D3.GE.0.D0) SINT3=((C5*C2)-DSQRT(D3))/C4                 00002220
ISN 0137          IF(D3.GE.0.D0) GHAT(1)=DARCOS(COST1)                        00002230
ISN 0139          IF(D3.GE.0.D0) GHAT(3)=DARCOS(COST3)                        00002240
                  C                                                           00002250
ISN 0141          IF(D4.GE.0.D0) COST2=((-C6*C1)+DSQRT(D2))/C4                00002260
ISN 0143          IF(D4.GE.0.D0) COST4=((-C5*C1)-DSQRT(D2))/C4                00002270
ISN 0145          IF(D4.GE.0.D0) SINT2=((C6*C2)+DSQRT(D4))/C4                 00002280
ISN 0147          IF(D4.GE.0.D0) SINT4=((C6*C2)-DSQRT(D4))/C4                 00002290
ISN 0149          IF(D4.GE.0.D0) GHAT(2)=DARCOS(COST2)                        00002300
ISN 0151          IF(D4.GE.0.D0) GHAT(4)=DARCOS(COST4)                        00002310
                  C                                                           00002320
                  C   CHECK TO SEE THAT THE ORIGINAL EQUATION IS SATISFIED    00002330
                  C                                                           00002340
ISN 0153          IF(D3.LT.0.D0) IFL=1                                        00002350
ISN 0155          IF(IFL.EQ.1) NTIMES=2                                       00002360
ISN 0157          IF(IFL.EQ.1) GO TO 120                                      00002370
ISN 0159          TEST=C1*COST1-C2*SINT3+C5                                   00002380
ISN 0160          IF(DABS(TEST).GT.1.D-10) TEMP=SINT3                         00002390
ISN 0162          IF(DABS(TEST).GT.1.D-10) SINT3=SINT1                        00002400
ISN 0164          IF(DABS(TEST).GT.1.D-10) SINT1=TEMP                         00002410
ISN 0166        120 IF(D4.LT.0.D0) IFL2=1                                     00002420
ISN 0168          IF(IFL2.EQ.1) NTIMES=NTIMES-2                               00002430
                  C                                                           00002440
                  C   IF THE SHIP NEVER ENTERS THE BAND OR IT NEVER LEAVES, CONTROL IS  00002450
                  C   RETURNED TO THE MAIN PROGRAM                            00002460
                  C                                                           00002470
ISN 0170          IF(NTIMES.EQ.0) RETURN                                      00002480
ISN 0172          IF(IFL2.EQ.1) GO TO 130                                     00002490
ISN 0174          TEST=C1*COST2-C2*SINT4+C6                                   00002500
ISN 0175          IF(DABS(TEST).GT.1.D-10) TEMP=SINT4                         00002510
ISN 0177          IF(DABS(TEST).GT.1.D-10) SINT4=SINT2                        00002520
ISN 0179          IF(DABS(TEST).GT.1.D-10) SINT2=TEMP                         00002530
                  C                                                           00002540
                  C   CALCULATE TIMES ON INTERVAL (0,2PI)                     00002550
                  C                                                           00002560
ISN 0181        130 IF(IFL.EQ.1) GO TO 140                                    00002570
ISN 0183          IF(SINT3.LT.0.D0) GHAT(1)=TPI-GHAT(1)                       00002580
```

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ISN 0185            IF(GHAT(1).LT.GHA0)  GHAT(1)=GHAT(1)+TPI                    00002590
ISN 0187            IF(SIN11.LT.0.D0)  GHAT(3)=TPI-GHAT(3)                      00002600
ISN 0189            IF(GHAT(3).LT.GHA0)  GHAT(3)=GHAT(3)+TPI                    00002610
ISN 0191          140 IF(IFL2.EQ.1) GO TO 150                                   00002620
ISN 0193            IF(SIN14.LT.0.D0)  GHAT(2)=TPI-GHAT(2)                      00002630
ISN 0195            IF(GHAT(2).LT.GHA0)  GHAT(2)=GHAT(2)+TPI                    00002640
ISN 0197            IF(SIN12.LT.0.D0)  GHAT(4)=TPI-GHAT(4)                      00002650
ISN 0199            IF(GHAT(4).LT.GHA0)  GHAT(4)=GHAT(4)+TPI                    00002660
ISN 0201          150 DO 160 K=1,4                                              00002670
ISN 0202            IF(((K.EQ.1).OR.(K.EQ.3)).AND.(IFL.EQ.1))  GO TO 160        00002720
ISN 0204            IF(((K.EQ.2).OR.(K.EQ.4)).AND.(IFL2.EQ.1))  GO TO 160       00002730
ISN 0206            T(K)=(GHAT(K)-GHA0)/RECIP                                   00002740
ISN 0207            THETA=THETA0-RECIP*T(K)                                     00002750
ISN 0208            ZORBT(K)=SINI*(X*DSIN(THETA)-Y*DCOS(THETA))+Z*COSI          00002760
ISN 0209            DZORBT(K)=RMSINI*(Y*DSIN(THETA)+X*DCOS(THETA))              00002770
ISN 0210          160 CONTINUE                                                  00002780
                  C                                                           00002790
                  C   RECORDER T---   T(1)=T(ENTER BAND), T(2)=T(LEAVE BAND), ETC...  00002800
                  C                                                           00002810
ISN 0211            IF(D3.LT.0.D0) T(1)=T(2)                                    00002820
ISN 0213            IF(D3.LT.0.D0) GHAT(1)=GHAT(2)                              00002830
ISN 0215            IF(D3.LT.0.D0) ZORBT(1)=ZORBT(2)                            00002840
ISN 0217            IF(D3.LT.0.D0) DZORBT(1)=DZORBT(2)                          00002850
ISN 0219            IF(D3.LT.0.D0) T(2)=T(4)                                    00002860
ISN 0221            IF(D3.LT.0.D0) GHAT(2)=GHAT(4)                              00002870
ISN 0223            IF(D3.LT.0.D0) ZORBT(2)=ZORBT(4)                            00002880
ISN 0225            IF(D3.LT.0.D0) DZORBT(2)=DZORBT(4)                          00002890
                  C                                                           00002900
ISN 0227            IF(D4.LT.0.D0) T(2)=T(3)                                    00002910
ISN 0229            IF(D4.LT.0.D0) GHAT(2)=GHAT(3)                              00002920
ISN 0231            IF(D4.LT.0.D0) ZORBT(2)=ZORBT(3)                            00002930
ISN 0233            IF(D4.LT.0.D0) DZORBT(2)=DZORBT(3)                          00002940
ISN 0235            N1=NTIMES-1                                                 00002950
                  C                                                           00002960
                  C   USE Z, DZ/DT TO DETERMINE WHETHER SHIP IS ENTERING OR LEAVING  00002970
                  C   THE BAND                                                 00002980
                  C                                                           00002990
ISN 0236            DO 180 K=1,NT,2                                           00003000
ISN 0237            IF(((ZORBT(K).GT.0.D0).AND.(DZORBT(K).LT.0.D0)).OR.       00003010
                   $      ((ZORBT(K).LT.0.D0).AND.(DZORBT(K).GT.0.D0)))  GO TO 170  00003020
ISN 0239            TIN=T(K+1)                                                00003030
ISN 0240            ZIN=ZORBT(K+1)                                            00003040
ISN 0241            DZIN=DZORBT(K+1)                                          00003050
ISN 0242            TOUT=T(K)                                                 00003060
ISN 0243            ZOUT=ZORBT(K)                                             00003070
ISN 0244            DZOUT=DZORBT(K)                                           00003080
ISN 0245            T(K)=TIN                                                  00003090
ISN 0246            ZORBT(K)=ZIN                                              00003100
ISN 0247            DZORBT(K)=DZIN                                            00003110
ISN 0248            T(K+1)=TOUT                                               00003120
ISN 0249            ZORBT(K+1)=ZOUT                                           00003130
ISN 0250            DZORBT(K+1)=DZOUT                                         00003140
                  C                                                           00003150
                  C   IF TIME INTERVAL STRADDLES 24 HOURS, CHANGE IT SO IT STRADDLES  00003160
```

```
                C   0 HOURS INSTEAD                                                    00003170
                C                                                                     00003180
ISN 0251          170 IF(T(K).GT.T(K+1)) T(K)=T(K)-TPIE                               00003190
                C                                                                     00003200
                C   CHECK TO SEE THAT TIMES WERE COMPUTED PROPERLY                    00003210
                C                                                                     00003220
ISN 0253            IF((DABS(T(K)).GT.35.D0).OR.(DABS(T(K+1)).GT.35.D0)) IERR=7       00003230
ISN 0255            IF(IWRE.NE.0) WRITE(6,16)                                         00003240
ISN 0257            IF(IERR.NE.0) RETURN                                              00003250
ISN 0259            IF(T(K).GT.T(K+1)) IERR=8                                         00003260
ISN 0261            IF(IERR.NE.0) WRITE(6,17)                                         00003270
ISN 0263            IF(IERR.NE.0) RETURN                                              00003280
ISN 0265            IF((T(K+1)-T(K)).GT.SIDDAY) IERR=9                                00003290
ISN 0267            IF(IERR.NE.0) WRITE(6,18)                                         00003300
ISN 0269            IF(IERR.NE.0) RETURN                                              00003310
ISN 0271          180 CONTINUE                                                        00003320
                C                                                                     00003330
                C   CALCULATE OTHER EARTH CROSSINGS                                  00003340
                C                                                                     00003350
ISN 0272            IF(NTIMES.EQ.2) T2=T(1)+T(2)                                      00003360
ISN 0274            IF(NTIMES.EQ.2) T(3)=T(1)-SIDDAY                                  00003370
ISN 0276            IF(NTIMES.EQ.2) T(4)=T(2)-SIDDAY                                  00003380
                C                                                                     00003390
ISN 0278            IF(NTIMES.EQ.4) T(5)=T(1)-SIDDAY                                  00003400
ISN 0280            IF(NTIMES.EQ.4) T(6)=T(2)-SIDDAY                                  00003410
ISN 0282            IF(NTIMES.EQ.4) T(7)=T(3)-SIDDAY                                  00003420
ISN 0284            IF(NTIMES.EQ.4) T(8)=T(4)-SIDDAY                                  00003430
                C                                                                     00003440
ISN 0286            IF(NTIMES.EQ.4) NTIMES=8                                          00003450
                C                                                                     00003460
ISN 0288            IF((NTIMES.EQ.2).AND.(T1.LT.0.D0)) T(5)=T(1)+SIDDAY               00003470
ISN 0290            IF((NTIMES.EQ.2).AND.(T1.LT.0.D0)) T(6)=T(2)+SIDDAY               00003480
ISN 0292            IF((NTIMES.EQ.2).AND.(T1.LT.0.D0)) NTIMES=6                       00003490
                C                                                                   * 00003517
                C                                                                   * 00003518
                C                                                                   * 00003519
                C                                                                   * 00003520
                C*******************************************************************00003530
                C                                                                     00003540
                C   DETERMINE IF COINCIDENCE EXISTS                                  00003550
                C                                                                     00003560
ISN 0294            CALL LCKGIT(IFOES,IERR)                                           00003570
ISN 0295            IF(IERR.NE.0) RETURN                                              00003580
                C                                                                     00003590
                C   CALCULATE TIME OF COINCIDENCE                                    00003600
                C                                                                     00003610
ISN 0297            DO 190 N=1,4                                                      00003620
ISN 0298            IF(IFOBS(N).NE.1) GO TO 190                                       00003630
ISN 0300            CALL GETTIM(N,IOES,TIME,IERR,NHALF,NITER,TCORR1,TCORR2)           00003640
ISN 0301            IF(IERR.NE.0) RETURN                                              00003650
ISN 0303          190 CONTINUE                                                        00003660
ISN 0304            RETURN                                                            00003670
ISN 0305            END                                                               00003730
```

NAM?	TAG	TYP%	ADD.	NAM%	TAG	TYP%	ADD.	NAM%	TAG	TYP%	ADD.	NAM%	TAG	TYP%	ADD.
K	SFA	I*4	00061C	N	SFA	I*4	000E2C	P	SF	R*8	0C0660	1	SFA C	R*8	000048
V	SF	R*8	000658	X	SF C	R*8	000000	Y	SF C	R*8	000008	Z	SF C	R*8	000010
C1	SF C	R*8	000038	C2	SF C	R*8	000040	C3	SF	R*8	0C0670	C4	SF	R*8	000678
C5	SF	R*8	000680	C6	SF	R*8	000688	D1	SFA	R*8	000690	D2	SFA	R*8	000698
D3	SFA	R*8	0006A0	D4	SFA	R*8	0006A8	G8	SFA	R*8	0006B0	I3	SF	I*4	000624
K1	SF	I*4	000628	PI	F	R*8	0006E8	RE	F	R*8	0C06C0	TT	S	R*8	0006C8
C1S	SF	R*8	0006D0	C2S	SF	R*8	0006D8	C5S	SF	R*8	0C06E0	C6S	SF	R*8	0006E8
DIR	SF	R*8	0006F0	IFI	S	I*4	000E2C	SPA	SFA	R*8	0006F8	TIM	SF	R*8	000700
TEI	SFA C	R*8	000030	ZIN	SF	R*8	C00706	ALAT	FA	R*8	000710	ALGN	F	R*8	000718
COSI	SF C	R*8	000028	DZIN	SF	R*8	000720	GHA1	SF	R*8	000910	GHA0	SF C	R*8	000098
GK2P	SF AE	R*8	000090	IIAY	SFA	I*4	000E30	I&RF	SFA	I*4	000638	IFL2	S	I*4	000638
BLAT	SFA	R*8	000728	RLOA	SFA	R*8	000730	SINI	SF C	R*8	000030	TFBE	SF	R*8	000738
TIST	S A	R*8	000740	TIMF	F		900102	TLIM	SFA	R*8	0007*8	TOBS	SFA XR	R*8	000000
TOOT	SF	R*8	000750	TPIE	SF C	R*8	0000A0	X&CI	SFA	R*8	0C0930	ZLIF	F	R*8	000758
ZCH1	SF	R*8	000760	ALON0	SF C	R*8	000C18	COSOM	SF C	R*8	0C00B0	COST1	SFA	R*8	000758
COST2	SFA	R*8	000770	COS13	SFA	R*8	000778	COS1P	SFA	R*8	000780	DZOU1	SF	R*8	000788
WLTS2	SFA	R*8	000960	EBOTE	SF C	R*8	000090	IFOBS	SFA XR	I*4	0C0000	IRFAD	S	I*4	00063C
IY?AR	SF	I*4	000640	IIAYE	SF	I*8	000E8F	LDAY0	SF	I*4	000648	LY?AR	F	I*4	0006*C
NHALF	SFA	I*8	000650	NIIPR	SFA	I*4	000E5F	OTIM?		R*8	000790	SINCR	SF C	R*8	0000A8
SINT1	SF	R*8	000798	SINT2	SF	R*8	0007A0	SINT3	SF	R*8	0C07A8	SIN1%	SF	R*8	0007B0
SR1VR	SF C	R*8	000020	TR2TA	SFA	R*8	0007B8	XSORB	SFA	R*8	0C07C0	YSORE	SFA	R*8	0007C8
ZORE1	SF	R*8	001338	DARCOS	XF	R*8	000C00	DTAN	XF	R*8	000000	ISQE3	XF	R*8	000030
DATAN2	XF	R*8	000000	DCOS	XF	R*8	000000	DSIN	XF	R*8	000000	ITSOBS	SFA	R*8	0007D0
DZORBT	SF	R*8	001358	PRSIN1	SF C	R*8	000088	PRDNL8	F XF	R*8	000000	FWRAL8	F XF	R*8	000000
GRTIIM	SF AE	R*8	000000	IECCE8	F XF	I*8	000000	IDAYIR	F	I*4	000658	IRLTS1	SF	I*4	0007E8
ITSOBS	FA	I*4	00065C	LCNGIT	SF XF	I*8	000000	NPIMPS	SF C	I*4	0000C8	PERIOD	S C	R*8	0000C0
SIGDAY	F	R*8	0007D8	TCORR1	SFA	R*8	0007E0	TCORR2	SFA	R*8	0007E8	TERTAC	SF	R*8	0007F0

***** COMMON INFORMATION *****

NAME OF COMMON BLOCK * CONST* SIZE OF BLOCK 0000CC HEXADECIMAL BYTES

VAR. NAME	TYP%	REL. ADDR.	VAR. NAME	TYP%	REL. ADDR.	VAR. NAME	TYP%	REL. ADDR.	VAR. NAME	TYP%	REL. ADDR.
X	R*8	000000	Y	R*8	000008	Z	R*8	000010	ALON0	R*8	000018
SR2VR	R*8	000020	CCSI	R*8	000028	SINI	R*8	000030	C1	R*8	000038
C2	R*8	000040	T	R*8	000048	TEI	R*8	000058	EBOTE	R*8	000090
GHA0	R*8	000098	TEIP	R*8	0000A0	SINCR	R*8	0000A8	CCSCR	R*8	0000B0
2RS1A1	R*8	0000E8	PERIOD	R*8	0000C0	NPIMPS	I*8	0000CE			

```
   LABEL   ADDR          LABEL   ADDR          LABEL   ADDR          LABEL   ADDR
     100   001666          110   001CCE          120   002114          130   0021A6
     140   0022DA          150   002276          160   002380          170   002522
     180   002654          190   002E16

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=56,SIZE=0000K,

*OPTIONS IN EFFECT*      SOURCE,RECFIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF

*STATISTICS*     SOURCE STATEMENTS =     304 ,PROGRAM SIZE =    10532

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******
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```
          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=56,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
   ISN 0002           SUBROUTINE LONGIT(IFOES,IERR)                                  00003750
                C                                                                    00003760
                C   SUBROUTINE LONGIT DETERMINES IF A COINCIDENCE EXISTS            00003770
                C                                                                    00003780
                C   INPUT VARIABLES:  T-- TIME VECTOR COMPUTED IN OTIME              00003790
                C                                                                    00003800
                C                      NTIMES--  THE NUMBER OF TIME INTERVALS TO BE  00003810
                C                                CHECKED FOR COINCIDENCES            00003820
                C   OUTPUT VARIABLES:  IFOES--  FLAG VECTOR                         00003830
                C                                                                    00003840
                C                      T--  TIME INTERVAL IS SHORTENED IF BAND     00003850
                C                           CROSSING TAKES MORE THAN HALF A PERIOD  00003860
                C                                                                    00003870
                C                      IERR--  ERROR FLAG                           00003880
                C                                                                    00003890
                C   FUNCTIONS CALLED:  XORB,YCBB                                    00003900
                C                                                                    00003910
                C   CALLED BY: OTIME                                                00003920
                C                                                                    00003925
                C   PROGRAMMED BY MICHAEL TOPOREK, SASC, 7/75                       00003926
                C                                                                    00003930
   ISN 0003           IMPLICIT REAL*8 (A-H,O-Z)                                      00003940
   ISN 0004           DIMENSION T(8),ALNSHP(6),ALNSAT(6),IFOES(4)                    00003950
   ISN 0005           DIMENSION TIME(6)                                              00003960
   ISN 0006           COMMON /CONST/ X,Y,Z,AICRO,SRNVH,COSI,SINI,C1,C2,T,TPI,        00003970
                     $      MBOTH,GHA0,TPIE,SIACH,COSOM,                            00003980
                     $      EBSINI,PERIOD,NTIMES                                    00003990
   ISN 0007           DATA PI/3.141592653589793D0/                                   00004000
   ISN 0008           DATA SIDDAY/23.93446560D0/                                     00004010
   ISN 0009          1 FORMAT(/20X,'*** ERROR(LONGIT) ** ABSOLUTE VALUE OF COMPUTED TIME '00004020
                     $      ,'IS GREATER THAN 35 HOURS ** ERROR(LONGIT) **'/)       00004030
   ISN 0010          2 FORMAT(/20X,'*** ERROR(LONGIT) ** TIME OF ENTRANCE INTO BAND IS ', 00004040
                     $      'GREATER THAN TIME OF EXIT ** ERROR(LONGIT) **'/)       00004050
   ISN 0011          3 FORMAT(/20X,'*** ERROR(LONGIT) ** THE SHIP IS IN THE BAND FOR MORE'00004060
                     $      ,' THAN ONE SIDEREAL DAY ** ERROR(LONGIT) **'/)         00004070
   ISN 0012           N2=NTIMES-1                                                    00004080
   ISN 0013           DO 140 N=1,N2,2                                                00004090
   ISN 0014           IFL2=0                                                         00004100
                C                                                                    00004110
                C   CHECK LENGTH OF TIME INTERVAL                                  00004120
                C                                                                    00004130
   ISN 0015           TIN=T(N)                                                       00004140
   ISN 0016           TOUT=T(N+1)                                                    00004150
   ISN 0017           XX=(TOUT-TIN)-(PERIOD/2.D0)                                    00004160
   ISN 0018           IF(XX.LT.0.D0) N=2                                             00004170
   ISN 0020           IF(XX.LT.0.D0) TIME(1)=TIN                                     00004180
   ISN 0022           IF(XX.LT.0.D0) TIME(2)=TOUT                                    00004190
   ISN 0024           IF(XX.LT.0.D0) GO TO 100                                       00004200
                C                                                                    00004210
                C   IF THE INTERVAL IS AT LEAST HALF A PERIOD, SPLIT IT INTO 3 PARTS 00004220
                C                                                                    00004230
   ISN 0026           IF((DABS(TOUT-TIN).GT.PERIOD).AND.(DABS(TIN).LT.DABS(TOUT)))   00004240
```

```
                     $      TOUT=TIN+PERIOD                                          00004240
ISN 0029                    IF((DABS(TOUT-TIN).GE.PERIOD).AND.(DABS(TIN).GT.DABS(TOUT)))  00004250
                     $      TIN=TOUT-PERIOD                                          00004260
ISN 0030                    DELTA=(TOUT-TIN)/3.D0                                    00004270
ISN 0031                    TIME(1)=TIN                                              00004280
ISN 0032                    TIME(2)=TIME(1)+DELTA                                    00004290
ISN 0033                    TIME(3)=TIME(2)                                          00004300
ISN 0034                    TIME(4)=TIME(3)+DELTA                                    00004310
ISN 0035                    TIME(5)=TIME(4)                                          00004320
ISN 0036                    TIME(6)=TOUT                                             00004330
ISN 0037                    M=6                                                      00004340
                    C                                                              00004350
                    C   CALCULATE LONGITUDE OF SHIP AND SATELLITE                  00004360
                    C                                                              00004370
ISN 0038              100 DO 110 I=1,M                                             00004380
ISN 0039                    GHA=GHA0+PHCTH*TIME(I)                                   00004390
ISN 0040                    ALNSHP(I)=DATAN2(YORB(GEB),XORB(GHA))                    00004400
ISN 0041                    IF(ALNSHP(I).LT.0.D0) ALNSHP(I)=TPI+ALNSHP(I)            00004410
ISN 0043                    ALNSAT(I)=DMOD((ALCK0+SREVH*TIME(I)),TPI)                00004420
ISN 0044                    IF(ALNSAT(I).LT.0.D0) ALNSAT(I)=TPI+ALNSAT(I)            00004430
ISN 0046              110 CONTINUE                                                 00004440
                    C                                                              00004450
                    C   IF SHIP AND/OR SATELLITE CROSS OVER THE LONGITUDE DISCONTINUITY  00004460
                    C   AT (360,0), MAKE ADJUSTMENTS TO LONGITUDES COMPUTED ABOVE  00004470
                    C                                                              00004480
ISN 0047                    MM=M-1                                                   00004490
ISN 0048                    DO 120 K=1,MM,2                                          00004500
ISN 0049                    IFL=0                                                    00004510
ISN 0050                    IF((ALNSHP(K)-ALNSHP(K+1)).LT.0.D0) ALNSHP(K)=ALNSHP(K)+TPI  00004520
ISN 0052                    IF((ALNSHP(K)-ALNSHP(K+1)).LT.0.D0) IFL=1                00004530
ISN 0054                    IF(((ALNSAT(K+1)-ALNSAT(K)).LT.0.D0).AND.(IFL.EQ.1))     00004540
                     $      ALNSAT(K+1)=ALNSAT(K+1)+TPI                              00004550
ISN 0056                    IF(((ALNSAT(K+1)-ALNSAT(K)).LT.0.D0).AND.((IFL.EQ.0).AND.  00004560
                     $      (ALNSHP(K).LT.PI))) ALNSAT(K)=ALNSAT(K)-TPI              00004570
ISN 0058                    IF(((ALNSAT(K+1)-ALNSAT(K)).LT.0.D0).AND.((IFL.EQ.0).AND.  00004580
                     $      (ALNSHP(K).GE.PI))) ALNSAT(K+1)=ALNSAT(K+1)+TPI          00004590
ISN 0060              120 CONTINUE                                                 00004600
                    C                                                              00004610
                    C   IF PRODUCT OF LONGITUDE DIFFERENCES IS NON-POSITIVE, COINCIDENCE  00004620
                    C   OCCURRED, AND A FLAG IS SET WHICH POINTS TO THE CORRECT INTERVAL  00004630
                    C                                                              00004640
ISN 0061                    DO 130 J=1,MM,2                                          00004650
ISN 0062                    IF(((ALNSAT(J)-ALNSHP(J))*(ALNSAT(J+1)-ALNSHP(J+1))).LT.0.D0)  00004660
                     $      IFL2=(J+1)/2                                             00004670
ISN 0064              130 CONTINUE                                                 00004680
ISN 0065                    IF(IFL2.EQ.0) GO TO 140                                  00004690
                    C                                                              00004700
                    C   SET FLAG WHICH TELLS MAIN PROGRAM THAT COINCIDENCE OCCURRED, AND  00004710
                    C   PUT TIME INTERVAL BACK INTO T                              00004720
                    C                                                              00004730
ISN 0067                    IFLAG((N+1)/2)=1                                         00004740
ISN 0068                    T(N)=TIME(2*IFL2-1)                                      00004750
ISN 0069                    T(N+1)=TIME(2*IFL2)                                      00004760
                    C                                                              00004770
```

```
                C   CHECK TO SEE THAT TIMES WERE COMPUTED PROPERLY                       00004780
                C                                                                       00004790
ISN 0070            IF((DABS(T(K)).GT.35.D0).OR.(DABS(T(K+1)).GT.35.D0)) IERR=10        00004800
ISN 0072            IF(IERR.NE.0) WRITE(6,1)                                            00004810
ISN 0074            IF(IERR.NE.0) RETURN                                                00004820
ISN 0076            IF(T(K).GT.T(K+1)) IERR=11                                          00004830
ISN 0078            IF(IERR.NE.0) WRITE(6,2)                                            00004840
ISN 0080            IF(IERR.NE.0) RETURN                                                00004850
ISN 0082            IF((T(K+1)-T(K)).GT.SIDAY) IERR=12                                  00004860
ISN 0084            IF(IERR.NE.0) WRITE(6,3)                                            00004870
ISN 0086            IF(IERR.NE.0) RETURN                                                00004880
ISN 0088          140 CONTINUE                                                          00004890
ISN 0089            RETURN                                                              00004900
                C     DEBUG INIT(ALNSAT,ALNSHF,T,FIN,TCOT,XX,IPL2,TIME,DELTA,M,IPOBS,N) 00004910
ISN 0090            END                                                                 00004920
```

NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.
I	SFA	I*4	000218	J	SF	I*4	00021C	K	SFA	I*4	000220	L	SF	I*4	000224
N	SF	I*4	000228	T	SFA C	R*8	000048	X	C	R*8	N.R.	Y	C	R*8	N.R.
Z	C	R*8	N.R.	C1	C	R*8	N.R.	C2	C	R*8	N.R.	NF	SF	I*4	00022C
NT	SF	I*4	000230	PI		R*8	000208	XX	S	R*8	000250	GNU	SFA	R*8	000258
IFL	S	I*4	000234	TIN	SFA	R*8	000260	TPI	FA C	R*8	000088	COSI	C	R*8	N.R.
GHAO	F C	R*8	000098	ISRF	S	I*4	000238	IFL2	SF	I*4	00023C	SINI	C	R*8	N.R.
TIME	SFA	R*8	000280	TOUT	SFA	R*8	000268	TPIF	C	R*8	N.R.	XORB	FA XF	R*8	000000
YORB	FA XF	R*8	000000	ALONO	FA C	R*8	000018	COSOM	C	R*8	N.R.	DELTA	SF	R*8	000270
EPOTH	F C	R*8	000090	IFOES	S XR	I*8	000000	SINCF	C	R*8	N.R.	SRAVE	FA C	R*8	000020
DATAN2	XF	R*8	000000	AINSAT	SF	R*8	0002E0	ALNSEP	SF	R*8	0002E0	PRSINI	C	R*8	N.R.
IBCCE#	F XF	I*8	000000	LONGIT		I*4	000240	NTIMES	F C	I*4	0000C8	PERIOD	F C	R*8	0000C0
SIDDAY		R*8	000278												

***** COMMON INFORMATION *****

NAME OF COMMON BLOCK * CONST* SIZE OF BLOCK 0000CC HEXADECIMAL BYTES

VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.
A	R*8	N.R.	Y	R*8	N.R.	Z	R*8	N.R.	ALONO	R*8	000018
SERVE	R*8	000020	COSI	R*8	N.R.	SINI	R*8	N.R.	C1	R*8	N.R.
C2	R*8	N.R.	T	R*8	000048	TPI	R*8	000088	EPOTH	R*8	000090
GHAO	R*8	000098	TEIE	R*8	N.R.	SINCM	R*8	N.R.	COSOM	R*8	N.R.
PRSINI	R*8	N.R.	PERIOD	R*8	0000C0	NTIMES	I*4	0000C8			

LABEL	ADDR	LABEL	ADDR	LABEL	ADDR	LABEL	ADDR
100	000512	110	0005D2	120	0006D4	130	000722
140	000872						

```
*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=56,SIZE=3000K,
*OPTIONS IN EFFECT*      SOURCE,RECDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
*STATISTICS*     SOURCE STATEMENTS =      89 ,PROGRAM SIZE =     2200
*STATISTICS*  NO  DIAGNOSTICS GENERATED
****** END OF COMPILATION ******
                                                    61K BYTES OF CORE NOT USED
```

```
          OPTIONS IN EFFECT: NAME= MAIN,OPT=02,LINECNT=56,SIZE=0000K,
                             SOURCE,EBCDIC,NOSEQ,NODECK,LOAD,MAP,NOEDIT,ID,XREF
ISN 0002            DOUBLE PRECISION FUNCTION XORB(GHA)                          00004930
                    C                                                            00004940
                    C   FUNCTION XORB CALCULATES THE X COORDINATE IN THE ECO SYSTEM 00004950
                    C                                                            00004960
                    C   INPUT VARIABLE:  GHA                                     00004970
                    C                                                            00004980
                    C   OUTPUT VARIABLE:  XORB                                   00004990
                    C                                                            00005000
                    C   CALLED BY:  LONGIT,GRIDIR                               00005010
                    C                                                            00005020
                    C   PROGRAMMED BY MICHAEL TOEPOKK, SASC, 7/79               00005025
                    C                                                            00005026
ISN 0003              IMPLICIT REAL*8 (A-H,O-Z)                                  00005030
ISN 0004              DIMENSION T(8)                                             00005040
ISN 0005              COMMON /CONST/ X,Y,Z,ALONO,ERRVH,COSI,SINI,C1,C2,T,III,    00005050
                     $     EBOTH,GHAO,TPIE,SINOM,COSOM,                         00005060
                     $     ERSINI,PERICD,NITERS                                  00005070
ISN 0006              XORB=C2*DCOS(GHA)+C1*DSIN(GHA)                             00005080
ISN 0007              RETURN                                                     00005090
ISN 0008              END                                                        00005110
```

NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.
T	C	R*8	N.R.	X	C	R*8	N.R.	Y	C	R*8	N.R.	Z	C	R*8	N.R.
C1	F C	R*8	000038	C2	F C	R*8	000040	GEA	FA	R*8	000080	TPI	C	R*8	N.R.
COSI	C	R*8	N.R.	GHAO	C	R*8	N.R.	SINI	C	R*8	N.R.	TPIF	C	R*8	N.R.
XORB S		R*8	000038	ALONO	C	R*8	N.R.	COSCM	C	R*8	N.R.	FSCIE	C	R*8	N.R.
SINCM	C	R*8	N.R.	SRIVH	C	R*8	N.R.	DEIN	XF	R*8	000000	DCOS	XF	R*8	000000
PRSINI	C	R*8	N.R.	NTIMES	C	I*4	N.R.	PERIOD	C	R*8	N.R.				

***** COMMON INFORMATION *****

NAME OF COMMON BLOCK * CONSI* SIZE OF BLOCK 0000CC HEXADECIMAL BYTES

VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.
X	R*8	N.R.	Y	R*8	N.R.	Z	R*8	N.R.	ALONO	R*8	N.R.
SERVE	R*8	N.R.	CCSI	R*8	N.R.	SINI	R*8	N.R.	C1	R*8	000038
C2	R*8	000040	T	R*8	N.R.	TPI	R*8	N.R.	IROTH	R*8	N.R.
GHAO	R*8	N.R.	TEIN	R*8	N.R.	SINCM	R*8	N.R.	COSOM	R*8	N.R.
PRSINI	R*8	N.R.	PERIOD	R*8	N.R.	NTIMES	I*4	N.R.			

OPTIONS IN EFFECT NAME= MAIN,OPT=02,LINECNT=56,SIZE=0000K,

OPTIONS IN EFFECT SOURCE,RECDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF

STATISTICS SOURCE STATEMENTS = 7 ,PROGRAM SIZE = 312

STATISTICS NO DIAGNOSTICS GENERATED

****** END OF COMPILATION ****** 77K BYTES OF CORE NOT USED

```
          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=56,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
ISN 0002            DOUBLE PRECISION FUNCTION YORB(GHA)                          00005120
                    C                                                            00005130
                    C   FUNCTION YORB CALCULATES THE Y COORDINATE IN THE ECO SYSTEM 00005140
                    C                                                            00005150
                    C   INPUT VARIABLE:  GHA                                     00005160
                    C                                                            00005170
                    C   OUTPUT VARIABLE:  YORB                                   00005180
                    C                                                            00005190
                    C   CALLED BY:  LONGIT,GETTIM                               00005200
                    C                                                            00005210
                    C   PROGRAMMED BY MICHAEL TOFORNE, SASC, 7/79               00005215
                    C                                                            00005216
ISN 0003              IMPLICIT REAL*8 (A-H,O-Z)                                  00005220
ISN 0004              DIMENSION T(3)                                             00005230
ISN 0005              COMMON /CONST/ X,Y,Z,AICNO,SENVH,COSI,SINI,C1,C2,T,TEI,    00005240
                     $     PROTR,GHAO,TPIR,SINCH,COSOM,                         00005250
                     $     ESSINI,PERIOD,NTIMES                                  00005260
ISN 0006              YORB=COSI*(-C1*DCOS(GHA)+C2*DSIN(GHA))+Z*SINI              00005270
ISN 0007              RETURN                                                     00005280
ISN 0008              END                                                        00005300
```

NAME	TAG		TYPE	ADD.	NAME	TAG		TYPE	ADD.	NAME	TAG		TYPE	ADD.	NAME	TAG		TYPE	ADD.
T		C	R*8	N.R.	X		C	R*8	N.R.	Y		C	R*8	N.R.	Z	F	C	R*8	000010
C1	F	C	R*8	000038	C2	F	C	R*8	000040	GEP	FA		R*8	0C0080	TPI		C	R*8	N.R.
COSI	F	C	R*8	000028	GHA0		C	R*8	N.R.	SINI	F	C	R*8	000030	TPIF		C	R*8	N.R.
YOBE	S		R*8	000088	ALCN0		C	R*8	N.R.	CCSOH		C	R*8	N.R.	EROTE		C	R*8	N.R.
SINCH		C	R*8	N.R.	SRAVE		C	R*8	N.R.	DSIN		XF	R*8	0C0060	DCOS		XF	R*8	000000
EESINI		C	R*8	N.R.	NTIMES		C	I*4	N.R.	PERIOD		C	R*8	N.R.					

***** COMMON INFORMATION *****

NAME OF COMMON BLOCK * COMSI* SIZE OF BLOCK 0000CC HEXADECIMAL BYTES

VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.
X	R*8	N.R.	Y	R*8	N.R.	Z	R*8	000010	ALCH0	R*8	N.R.
SRAVE	R*8	N.R.	CCSI	R*8	000028	SINI	R*8	000030	C1	R*8	000038
C2	R*8	000040	T	R*8	N.R.	TPI	R*8	N.R.	EROTE	R*8	N.R.
GHA0	R*8	N.R.	TPIE	R*8	N.R.	SINCH	R*8	N.R.	CCSOH	R*8	N.R.
EESINI	R*8	N.R.	PERIOD	R*8	N.R.	NTIMES	I*4	N.R.			

OPTIONS IN EFFECT NAME= MAIN,OPT=02,LINECNT=56,SIZE=0000K,

OPTIONS IN EFFECT SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF

STATISTICS SOURCE STATEMENTS = 7 ,PROGRAM SIZE = 326

STATISTICS NO DIAGNOSTICS GENERATED

****** END OF COMPILATION ****** 77K BYTES OF CORE NOT USED

```
        COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=56,SIZE=0000K,
                           SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
ISN 0002          SUBROUTINE GETTIM(N,TOBS,TLIM,IERR,NHALF,NITER,TCORR1,TCORR2)      00005310
                  C                                                                  00005320
                  C   SUBROUTINE GETTIM CALCULATES THE TIME OF COINCIDENCE          00005330
                  C                                                                  00005340
                  C                                                                  00005350
                  C   INPUT VARIABLES:  N--  USED TO SELECT COMPONENTS OF THE VECTOR T 00005360
                  C                         TO BE USED AS INITIAL ENDPOINTS          00005370
                  C                                                                  00005380
                  C                     TLIM--  MAX. LENGTH OF FINAL TIME INTERVAL   00005390
                  C                                                                  00005400
                  C                     NITER--  NUMBER OF ITERATIONS TO BE DONE BEFORE 00005410
                  C                              INTERVAL IS HALVED                  00005420
                  C                                                                  00005430
                  C                     NHALF--  NUMBER OF TIMES TIME INTERVAL IS TO 00005440
                  C                              BE HALVED BEFORE ATTEMPT AT CONVER- 00005450
                  C                              IS TO BE ABANDONED.  THE MAX. NUM-  00005460
                  C                              BER OF ITERATIONS IS NHALF*NITER    00005470
                  C                                                                  00005480
                  C                     T--   TIME VECTOR(COMPUTED BY GTIME, POSSIBLY 00005490
                  C                                   MODIFIED BY LONGIT)            00005500
                  C                                                                  00005510
                  C                     TCORR1, TCORR2-- EMPIRICAL FACTORS USED TO   00005515
                  C                                      CORRECT FOR ERRORS IN THE CAL- 00005516
                  C                                      CULATED TIME OF COINCIDENCE 00005517
                  C                                                                  00005518
                  C   OUTPUT VARIABLES:  TOBS--  TIME VECTOR WHICH CONTAINS         00005520
                  C                              TIMES OF COINCIDENCES               00005530
                  C                                                                  00005540
                  C                      IERR-- ERROR FLAG                           00005550
                  C                                                                  00005560
                  C   FUNCTIONS CALLED:  XORE, YORE                                  00005570
                  C                                                                  00005580
                  C   CALLED BY: GTIME                                              00005590
                  C                                                                  00005600
                  C   PROGRAMMED BY MICHAEL TOFOREK, SASC, 7/79                     00005605
                  C                                                                  00005606
ISN 0003            IMPLICIT REAL*8 (A-H,O-Z)                                        00005610
ISN 0004            DIMENSION T(8),TOBS(8)                                           00005620
ISN 0005            COMMON /CONST/ X,Y,Z,AICSO,SERVH,COSI,SINI,C1,C2,E,TEI,          00005630
                   $     BEOTH,GHRO,IPIP,SIECH,COSOH,                                00005640
                   $     BRSINI,PERIOD,NTIERS                                        00005650
ISN 0006            DATA PI/3.1415926535897930/                                      00005660
ISN 0007           3 FORMAT(2X,'** ERROR(GETTIM) ** DIFLN1*DIFLN2 .GT. 0:   ALNST1=', 00005690
                   $     F9.5,' ALNST2=',F9.5,' ALNSP1=',F9.5,' ALNSP2=',F9.5,       00005700
                   $     '  ** ERROR(GETTIM) **')                                    00005710
ISN 0008           4 FORMAT(/20X,'** ERROR(GETTIM) ** CONVERGENCE NOT REACHED AFTER ', 00005720
                   $     I7,' ITERATIONS, FINAL TIME INTERVAL IS (',F15.9,',',       00005730
                   $     F15.9,')       ** ERROR(GETTIM) **')                       00005740
ISN 0009           5 FORMAT(/20X,'** ERROR(GETTIM) ** ABSOLUTE VALUE OF TIME OF COINCI 00005750
                   $     ,'DENCE IS GREATER THAN 30 HOURS ** ERROR(GETTIM) **')      00005760
ISN 0010            IFL=0                                                           00005810
                  C                                                                  00005820
```

```
C   T1= TIME SHIP ENTERS BAND                                          00005830
C   T2= TIME SHIP LEAVES BAND                                          00005840
C                                                                      00005850
C   FIRST CALCULATE LONGITUDES OF SHIP AND SATELLITE AT THESE TIMES    00005860
C                                                                      00005870
ISN 0011        T1=T(2*N-1)                                            00005880
ISN 0012        T2=T(2*N)                                              00005890
ISN 0013        ALNST1=DMOD((ALON0+SRZVH*T1),TPI)                      00005900
ISN 0014        ALNST2=DMOD((ALON0+SRZVH*T2),TPI)                      00005910
ISN 0015        IF(ALNST1.LT.0.D0) ALNST1=TPI+ALNST1                   00005920
ISN 0017        IF(ALNST2.LT.0.D0) ALNST2=TPI+ALNST2                   00005930
ISN 0019        GHA1=GHA0+REOTH*T1                                     00005940
ISN 0020        GHA2=GHA0+REOTH*T2                                     00005950
ISN 0021        ALNSP1=DATAN2(YORB(GHA1),XORB(GHA1))                   00005960
ISN 0022        ALNSP2=DATAN2(YORB(GHA2),XORB(GHA2))                   00005970
ISN 0023        IF(ALNSP1.LT.0.D0) ALNSP1=TPI+ALNSP1                   00005980
ISN 0025        IF(ALNSP2.LT.0.D0) ALNSP2=TPI+ALNSP2                   00005990
ISN 0027        IF((ALNSP1-ALNSP2).LT.0.D0) ALNSP1=ALNSP1+TPI          00006000
ISN 0029        IF((ALNSP1-ALNSP2).LT.0.D0) IFL=1                      00006010
ISN 0031        IF(((ALNST2-ALNST1).LT.0.D0).AND.(IFL.EQ.1))ALNST2=ALNST2+TPI  00006020
ISN 0033        IF(((ALNST2-ALNST1).LT.0.D0).AND.((IFL.EQ.0).AND.(ALNSP1.LT.PI)))  00006030
               $     ALNST1=ALNST1-TPI                                 00006040
ISN 0035        IF(((ALNST2-ALNST1).LT.0.D0).AND.((IFL.EQ.0).AND.(ALNSP1.GT.PI)))  00006050
               $     ALNST2=ALNST2+TPI                                 00006060
C                                                                      00006070
C   FIND TIMES THAT SATELLITE CROSSES SHIP LONGITUDE INTERVAL AND      00006080
C   RECALCULATE LONGITUDES OF SHIP AND SATELLITE AT THE NEW TIMES      00006090
C                                                                      00006100
ISN 0037        IF(ALNSP2.LT.ALNST1) GO TO 100                         00006110
ISN 0039        T1=T1+(ALNSP2-ALNST1)/SRZVH                            00006120
ISN 0040        ALNST1=ALNSP2                                          00006130
ISN 0041      100 IF(ALNSP1.GT.ALNST2) GO TO 110                       00006140
ISN 0043        T2=T2+(ALNSP1-ALNST2)/SRZVH                            00006150
ISN 0044        ALNST2=ALNSP1                                          00006160
ISN 0045      110 GHA1=GHA0+REOTH*T1                                   00006170
ISN 0046        GHA2=GHA0+REOTH*T2                                     00006180
ISN 0047        ALNSP1=DATAN2(YORB(GHA1),XORB(GHA1))                   00006190
ISN 0048        ALNSP2=DATAN2(YORB(GHA2),XORB(GHA2))                   00006200
ISN 0049        IF(ALNSP1.LT.0.D0) ALNSP1=TPI+ALNSP1                   00006210
ISN 0051        IF(ALNSP2.LT.0.D0) ALNSP2=TPI+ALNSP2                   00006220
ISN 0053        IF((ALNSP1-ALNSP2).LT.0.D0) ALNSP1=ALNSP1+TPI          00006230
ISN 0055        IF((ALNSP1.LT.PI).AND.(ALNST2.GT.TPI)) ALNST1=ALNST1-TPI  00006240
ISN 0057        IF((ALNSP1.LT.PI).AND.(ALNST2.GT.TPI)) ALNST2=ALNST2-TPI  00006250
ISN 0059        DIFLN1=ALNSP1-ALNST1                                   00006260
ISN 0060        DIFLN2=ALNSP2-ALNST2                                   00006270
C                                                                      00006280
C   THE LONGITUDE DIFFERENCES MUST HAVE DIFFERENT SIGNS.  IF THEY      00006290
C   DON'T, RETURN                                                      00006300
C                                                                      00006310
ISN 0061        IF((DIFLN1*DIFLN2).GT.0.D0) IERF=13                    00006320
ISN 0063        IF(IERF.NE.0) WRITE(6,3) ALNST1,ALNST2,ALNSP1,ALNSP2   00006330
ISN 0065        IF(IERF.NE.0) RETURN                                   00006340
C                                                                      00006350
C   USE MODIFIED REGULA FALSI TO FIND TIME OF COINCIDENCE              00006360
```

```
C   IF CONVERGENCE NOT REACHED AFTER EVERY NITER ITERATIONS, HALVE THE  00006370
C   TIME INTERVAL                                                       00006380
C   IF CONVERGENCE NOT REACHED AFTER NHALF*NITER ITERATIONS, STOP LOOP- 00006390
C   ING, SET IERF EQUAL TO THE MAX. NUMBER OF ITERATIONS AND RETURN     00006400
C                                                                       00006410
ISN 0067        DO 130 I=1,NHALF                                        00006420
ISN 0068        IF(I.EQ.1) GO TO 120                                    00006430
ISN 0070        THALF=T1+(T2-T1)/2.D0                                   00006440
ISN 0071        ALNSTH=ALNST2+SRPVH*(THALF-T2)                          00006450
ISN 0072        GHAH=GHA0+OMEGTH*THALF                                  00006460
ISN 0073        ALNSPH=DATAN2(YORB(GHAH),XORB(GHAH))                    00006470
ISN 0074        IF(ALNSPH.LT.0.D0) ALNSPH=TPI+ALNSPH                    00006480
ISN 0076        IF((ALNSPH.GT.0.D0).AND.(ALNSP1.GT.TPI)) ALNSPH=TPI+ALNSPH 00006490
ISN 0078        DIFLNH=ALNSPH-ALNSTH                                    00006500
ISN 0079        YZ=DIFLNH*DIFLN2                                        00006510
ISN 0080        IF(YZ.LT.0.D0) T1=THALF                                 00006520
ISN 0082        IF(YZ.LT.0.D0) DIFLN1=DIFLNH                            00006530
ISN 0084        IF(YZ.GT.0.D0) T2=THALF                                 00006540
ISN 0086        IF(YZ.GT.0.D0) DIFLN2=DIFLNH                            00006550
ISN 0088        IF((T2-T1).LT.TLIM) GO TO 140                           00006560
ISN 0090      120 DO 130 J=1,NITER                                      00006570
ISN 0091        STEP=.01D0*(T2-T1)                                      00006580
ISN 0092        T3=T2*(DIFLN1/(DIFLN1-DIFLN2))+T1*(DIFLN2/(DIFLN2-DIFLN1)) 00006590
ISN 0093        F=T3-T2                                                 00006600
ISN 0094        G=T3-T1                                                 00006610
ISN 0095        IF(DABS(F).LT.DABS(G)) T3=T3-STEP                       00006620
ISN 0097        IF(DABS(F).GT.DABS(G)) T3=T3+STEP                       00006630
ISN 0099        ALNST3=ALNST2+SRPVH*(T3-T2)                             00006640
ISN 0100        GHA3=GHA0+OMEGTH*T3                                     00006650
ISN 0101        ALNSP3=DATAN2(YORB(GHA3),XORB(GHA3))                    00006660
ISN 0102        IF(ALNSP3.LT.0.D0) ALNSP3=TPI+ALNSP3                    00006670
ISN 0104        IF((ALNSP3.GT.0.D0).AND.(ALNSP1.GT.TPI)) ALNSP3=TPI+ALNSP3 00006680
ISN 0106        DIFLN3=ALNSP3-ALNST3                                    00006690
ISN 0107        YZ=DIFLN3*DIFLN2                                        00006700
ISN 0108        IF(YZ.LT.0.D0, T1=T3                                    00006710
ISN 0110        IF(YZ.LT.0.D0) DIFLN1=DIFLN3                            00006720
ISN 0112        IF(YZ.GT.0.D0) T2=T3                                    00006730
ISN 0114        IF(YZ.GT.0.D0) DIFLN2=DIFLN3                            00006740
ISN 0116        IF((T2-T1).LT.TLIM) GO TO 140                           00006750
ISN 0118      130 CONTINUE                                              00006760
ISN 0119        IERF=NHALF*NITER                                        00006770
ISN 0120        WRITE(6,4) IERF,T1,T2                                   00006780
ISN 0121        RETURN                                                  00006790
C                                                                       00006800
C   PUT FINAL TIME INTERVAL INTO TOBS AND RETURN                        00006810
C                                                                       00006820
ISN 0122      140 TOBS(N)=(T1+T2)/2.D0                                  00006830
C                                                                       00006835
C   APPLY TIME CORRECTION FUDGE                                         00006836
C                                                                       00006837
ISN 0123        TOBS(N)=TOBS(N)+((TCORR1*TOBS(N)+TCORR2)/60.D0)         00006840
C                                                                       00006849
ISN 0124        IF(DABS(TOBS(N)).GT.30.D0) IERF=10                      00006850
ISN 0126        IF(IHPF.NE.0) WRITE(6,5)                                00006860
```

```
ISN 0128          RETURN                                                                00006870
                  C     DEBUG INIT (T1,T2,T3,DIFLN1,DIFLN2,DIFLN3,ALNST1,ALNST2,ALNST3,  00006880
ISN 0129          C    $      ALNSP1,AINSE2,AINSE3,TRILP,DIFLNH)                        00006890
                          END                                                           00006900
```

NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.
F	S A	R*8	000298	G	S A	R*8	0002A0	I	SF	I*4	00027C	J	SF	I*4	000280
N	FA	I*4	000284	T	F C	R*8	000038	X	C	R*8	N.R.	Y	C	R*8	N.R.
Z	C	R*8	N.R.	C1	C	R*8	N.R.	C2	C	R*8	N.R.	PI		R*8	000208
T1	SFA	R*8	0002E0	T2	SFA	R*8	0002E8	T3	SF	R*8	0002C0	YZ	S	R*8	0002C8
IFL	S	I*4	000288	TPI	FA C	R*8	000088	COSJ	C	R*8	N.R.	GHAF	SFA	R*8	000200
GHA0	F C	R*8	000098	GHA1	SFA	R*8	0002D8	GHA2	SFA	R*8	0002F0	GHA3	SFA	R*8	0002A8
IERF	SF	I*4	00028C	SINI	C	R*8	N.R.	STEP	SF	R*8	0002E0	TIME		R*8	0002F8
TOBS	SFA XF	R*8	000000	TPI8	C	R*8	N.R.	XORB	FA XF	R*8	000000	YORE	FA XF	R*8	000000
AIONO	FA C	R*8	000018	COSOM	C	R*8	N.R.	ZEOTH	F C	R*8	000090	NHALF	F	I*4	000290
NITER	F	I*8	000298	SINCM	C	R*8	N.R.	SRAVH	FA C	R*8	000020	THALF	SF	R*8	000300
DATAN2	XF	R*8	000000	ALNSPH	SF	R*8	000308	ALNSP1	SF	R*8	000310	ALNSP2	SF	R*8	000318
ALNSP3	SF	R*8	000320	AINSIH	SF	R*8	000328	ALNSI1	SF	R*8	000330	ALNSI2	SF	R*8	000338
ALNSI3	SF	R*8	000340	DIFLNB	SF	R*8	000348	DIFLN1	SF	R*8	000350	DIFLN2	SF	R*8	000358
DIFLN3	SF	R*8	000360	RESINI	C	R*8	N.R.	GETTIM		R*8	000368	IECOM8	F XF	I*4	000000
NTIMES	C	I*8	N.R.	PERIOD	C	R*8	N.R.	TCORF1	F	R*8	000370	TCORR2	F	R*8	000378

***** COMMON INFORMATION *****

NAME OF COMMON BLOCK * CONST* SIZE OF BLOCK 0000CC HEXADECIMAL BYTES

VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.	VAR. NAME	TYPE	REL. ADDR.
I	S*8	N.R.	Y	R*8	N.R.	Z	R*8	N.R.	ALONG	R*8	000018
SERVE	R*8	000020	COSI	R*8	N.R.	SINI	R*8	N.R.	C1	R*8	N.R.
C2	R*8	N.R.	T	R*8	000048	TPI	R*8	000088	ZEOTH	R*8	000090
GHAU	R*8	000098	TEIR	R*8	N.R.	SINCM	R*8	N.R.	COSOM	R*8	N.R.
ERSIAI	R*8	N.R.	PERIOD	R*8	N.R.	NTIMES	I*4	N.R.			

```
   LABEL   ADDR          LABEL   ADDR          LABEL   ADDR          LABEL   ADDR
     100   000670        110   000692          120   000960          130   000E0C
     140   000E4C

*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=56,SIZE=0000K,

*OPTIONS IN EFFECT*      SOURCE,EXECDIC,NOLIST,NODECK,LOAD,MAP,NOSDIT,ID,XREF

*STATISTICS*     SOURCE STATEMENTS =     128 ,PROGRAM SIZE =     3134

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******

                                                    53K BYTES OF CORE NOT USED
```

```
      COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=56,SIZE=0000K,
                         SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
ISN 0002              SUBROUTINE GKEP(XMU,X,IFL)                                00000010
                    C                                                           00000020
                    C   SUBROUTINE GKEP CONVERTS THE KEPLERIAN ORBITAL ELEMENTS TO 00000030
                    C   ECI COORDINATES                                         00000040
                    C                                                           00000050
                    C   INPUT VARIABLES:  X-- 6-ELEMENT VECTOR CONTAINING KEPLERIAN 00000060
                    C                        COORDINATES                        00000070
                    C                                                           00000080
                    C   OUTPUT VARIABLES:  X-- ECI COORDINATES                  00000090
                    C                                                           00000100
                    C                      IFL-- ERROR FLAG                     00000110
                    C                                                           00000115
                    C   CONSTANT:  XMU-- GRAVITATIONAL CONSTANT TIMES MASS OF THE EARTH 00000116
                    C                                                           00000120
ISN 0003              IMPLICIT REAL*8 (A-H,O-Z)                                 00000130
ISN 0004              DIMENSION X(6)                                            00000140
ISN 0005              EPS=1.D-35                                                00000150
ISN 0006              A=X(1)                                                    00000160
ISN 0007              E=X(2)                                                    00000170
ISN 0008              XI=X(3)                                                   00000180
ISN 0009              XN=X(4)                                                   00000190
ISN 0010              W=X(5)                                                    00000200
ISN 0011              XM=X(6)                                                   00000210
ISN 0012              IFL=1                                                     00000220
ISN 0013              IF((E.GT.1.D0).OR.(E.LT.0.D0)) GO TO 120                  00000230
ISN 0015              IF((A.LE.0.D0).OR.(A.GT.1.D35)) GO TO 120                 00000240
ISN 0017              EP=XM                                                     00000250
ISN 0018              J=1                                                       00000260
ISN 0019            100 EX=XM+E*DSIN(EP)                                        00000270
ISN 0020              IF(DABS(EX-EP).LT.EPS) GO TO 110                          00000280
ISN 0022              IF(J.EQ.10) GO TO 110                                     00000290
ISN 0024              EP=EX                                                     00000300
ISN 0025              J=J+1                                                     00000310
ISN 0026              GO TO 100                                                 00000320
ISN 0027            110 COSX=DCOS(EX)                                           00000330
ISN 0028              SINX=DSIN(EX)                                             00000340
ISN 0029              B=DSQRT(XMU/A)/(1.D0-E*COSX)                              00000350
ISN 0030              XW=A*(COSX-E)                                             00000360
ISN 0031              YW=A*SINX*DSQRT(1.D0-E*E)                                 00000370
ISN 0032              XWD=-B*SINX                                               00000380
ISN 0033              YWD=B*COSX*DSQRT(1.D0-E*E)                                00000390
ISN 0034              COSW=DCOS(W)                                              00000400
ISN 0035              COSO=DCOS(XN)                                             00000410
ISN 0036              COSI=DCOS(XI)                                             00000420
ISN 0037              SINW=DSIN(W)                                              00000430
ISN 0038              SINO=DSIN(XN)                                             00000440
ISN 0039              SINI=DSIN(XI)                                             00000450
ISN 0040              PX=COSW*COSO-SINW*SINO*COSI                               00000460
ISN 0041              QX=-SINW*COSO-COSW*SINO*COSI                              00000470
ISN 0042              PY=COSW*SINO +SINW*COSO*COSI                              00000480
ISN 0043              QY=-SINW*SINO+COSW*COSO*COSI                              00000490
ISN 0044              PZ=SINW*SINI                                              00000500
```

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ISN 0045            QZ=COSW*SINI                                    00000510
ISN 0046            X(1)=XW*PX+YW*QX                                00000520
ISN 0047            X(2)=XW*PY+YW*QY                                00000530
ISN 0048            X(3)=XW*PZ+YW*QZ                                00000540
ISN 0049            X(4)=XWD*PX+YWD*QX                              00000550
ISN 0050            X(5)=XWD*PY+YWD*QY                              00000560
ISN 0051            X(6)=XWD*PZ+YWD*QZ                              00000570
ISN 0052            IFL=0                                           00000580
ISN 0053        120 RETURN                                          00000590
ISN 0054            END                                             00000600
```

NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.	NAME	TAG	TYPE	ADD.
A	SFA	R*8	0000E0	B	SF	R*8	0000F0	F	SFA	R*8	0C0100	J	SF	I*4	000078
W	SFA	R*8	0001C8	X	SF XR	R*8	000000	EP	SFA	R*8	000110	PX	SFA	R*8	000118
PY	SF	R*8	000120	PZ	SF	R*8	000128	QZ	SF	R*8	0C0130	QX	SF	R*8	000138
QY	SF	R*8	000140	XI	SFA	R*8	0C0150	XN	SFA	R*8	000160	XW	SF	R*8	000168
IFI	S	I*4	0000FC	YW	SF	R*8	000170	XX	SF	R*8	000178	YY	S	R*8	000190
XMO	FA	R*8	000180	XXI	SF	R*8	C00188	COSC	SF	R*8	0001A0	COSW	SF	R*8	0001A8
COSI	SF	R*8	0001B0	SINI	SF	R*8	0001C0	SINO	SF	R*8	0C01C8	SINW	SF	R*8	0001D0
GKEE		R*8	000188	DSQRT	XF	R*8	C00000	DCOS	XF	R*8	000000	DSIN	XF	R*8	000000
SIBX	SF	R*8	0001D8												

```
   LABEL   ADDR          LABEL   ADDR          LABEL   ADDR          LABEL   ADDR
     100   000220          110   000322          120   000580
*OPTIONS IN EFFECT*      NAME=  MAIN,OPT=02,LINECNT=56,SIZE=0000K,
*OPTIONS IN EFFECT*      SOURCE,RECFM,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,XREF
*STATISTICS*     SOURCE STATEMENTS =      53 ,PROGRAM SIZE =     1450
*STATISTICS*  NO  DIAGNOSTICS GENERATED
****** END OF COMPILATION ******
                                                        73K BYTES OF CORE NOT USED
*STATISTICS*  NO  DIAGNOSTICS THIS STEP
```